GRADE 12 DIPLOMA EXAMINATION

Chemistry 30

June 1990

Alberta
EDUCATION

GRADE 12 DIPLOMA EXAMINATION
CHEMISTRY 30

DESCRIPTION

Time: 2½ hours

Total possible marks: 70

This is a **closed-book** examination consisting of **three** parts:

PART A has 49 multiple-choice questions each with a value of one mark.

PART B has seven machine-scorable open-ended questions each with a value of one mark.

PART C has three written-response questions for a total of 14 marks.

A chemistry data booklet is provided for your reference.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work. **No marks** will be given for work done on the tear-out pages.

GENERAL INSTRUCTIONS

Fill in the information required on the answer sheet and the examination booklet as directed by the examiner.

You are expected to provide your own approved scientific calculator.

Carefully read the instructions for each part before proceeding.

DO NOT FOLD EITHER THE ANSWER SHEET OR THE EXAMINATION BOOKLET.

The presiding examiner will collect your answer sheet and examination booklet and send them to Alberta Education.

JUNE 1990

PART A

INSTRUCTIONS

In this part of the examination, there are 49 multiple-choice questions each with a value of one mark. All numbers used in the questions are to be considered as the result of a measurement.

Read each question carefully and decide which of the choices **best** completes the statement or answers the question. Locate that question number on the separate answer sheet provided and fill in the space that corresponds to your choice. **Use an HB pencil only.**

Example

This diploma examination is for the subject area of

A. Biology
B. Physics
C. Chemistry
D. Mathematics

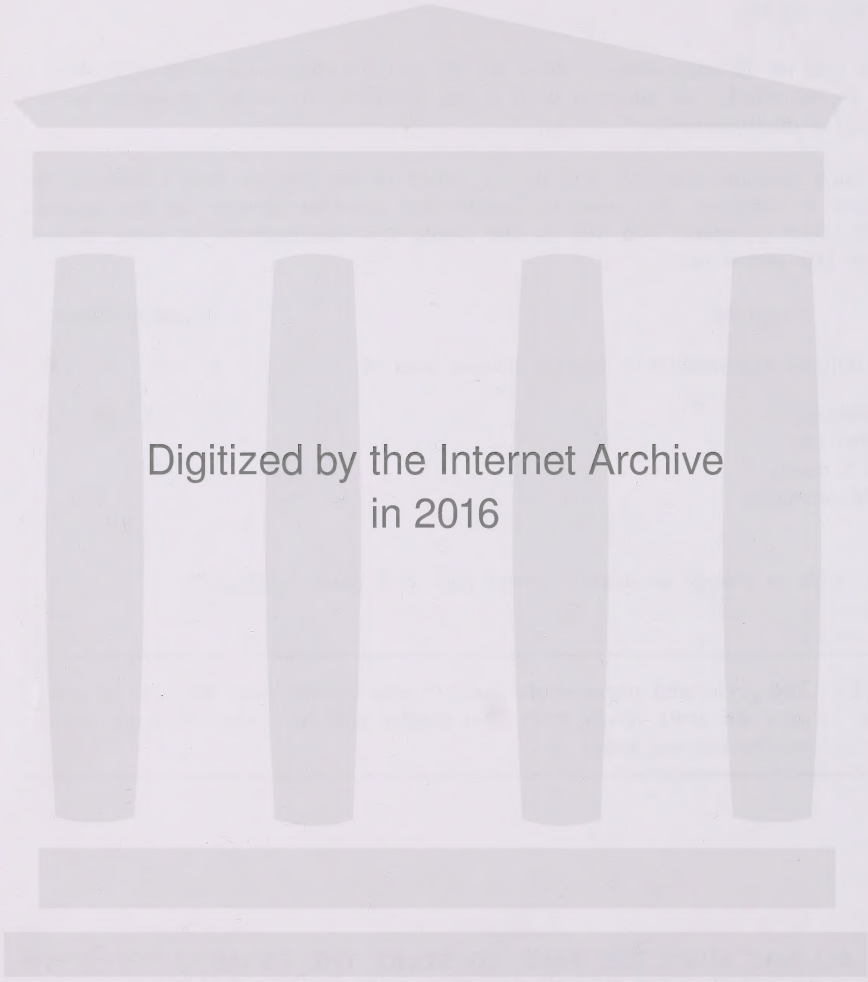
Answer Sheet

A	B	C	D
①	②	●	④

If you wish to change an answer, erase your first mark completely.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work. **No marks** will be given for work done on the tear-out pages.

DO NOT TURN THE PAGE TO START THE EXAMINATION UNTIL TOLD TO DO SO BY THE PRESIDING EXAMINER.



1. An example of a change in kinetic energy **only** is

A. steam condensing at 100°C
B. molten aluminum solidifying at 660°C
C. dry ice cooling from $-80°C$ to $-100°C$
D. hydrogen nuclei fusing above $1.0 \times 10^{7}°C$

2. The equation that is for a heat of formation is

A. $Sn(s) + \frac{1}{4}S_8(s) \longrightarrow SnS_2(s)$

B. $SnS_2(s) \longrightarrow Sn(s) + \frac{1}{4}S_8(s)$

C. $SnS_2(s) \longrightarrow SnS_2(l)$

D. $SnS_2(l) \longrightarrow SnS_2(s)$

3. Given the reaction $2N_2(g) + O_2(g) \longrightarrow 2N_2O(g)$ $\Delta H = +164.0$ kJ, what is the heat evolved when 1.0 g of $N_2O(g)$ decomposes into its elements?

A. 1.6×10^{2} kJ
B. 84 kJ
C. 1.9 kJ
D. 2.3×10^{-2} kJ

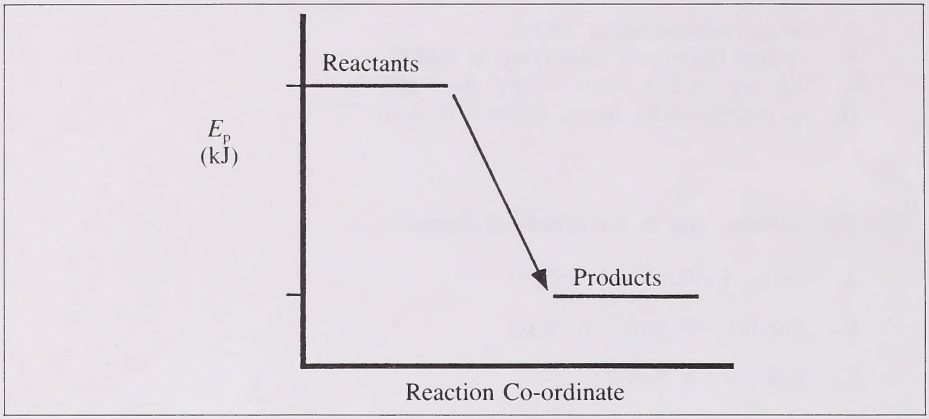
4. The most stable chemical compounds are those with standard heats of formation that have a numerical value that is

A. large and positive
B. large and negative
C. small and positive
D. small and negative

5. An example of an endothermic reaction is the

A. burning of methane
B. formation of propane from its elements
C. decomposition of ethyne into its elements
D. decomposition of liquid water into its elements

Use the following diagram to answer question 6.



6. The reaction shown in the diagram is

A. exothermic and ΔH is negative
B. exothermic and ΔH is positive
C. endothermic and ΔH is negative
D. endothermic and ΔH is positive

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7. While preparing a 1.00 mol/L solution of sulphuric acid from a commercial supply, a student noticed that the preparation beaker became hot to touch. This might best be explained as a change of

A. physical energy to chemical energy
B. bond energy to potential energy
C. potential energy to bond energy
D. bond energy to kinetic energy

8. Select the reaction that would generate the most energy.

A. $H_2O(g) \longrightarrow H_2O(l)$

B. $CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(g)$

C. $2AgNO_3(aq) + Cu(s) \longrightarrow Cu(NO_3)_2(aq) + 2Ag(s)$

D. ${}^{2}_{1}H + {}^{3}_{1}H \longrightarrow {}^{4}_{2}He + {}^{1}_{0}n$

Use the following information to answer question 9.

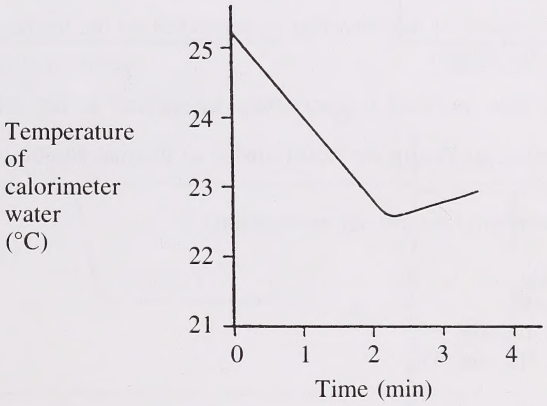
$\frac{1}{8}S_8(s) + \frac{3}{2}O_2(g) \longrightarrow SO_3(g)$	$\Delta H = -395.2$ kJ/mol
$H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(l)$	$\Delta H = -285.9$ kJ/mol
$H_2(g) + \frac{1}{8}S_8(s) + 2O_2(g) \longrightarrow H_2SO_4(l)$	$\Delta H = -811.3$ kJ/mol

9. When sulphur trioxide gas reacts with water according to the equation $SO_3(g) + H_2O(l) \longrightarrow H_2SO_4(l)$, the heat of reaction is

A. -130.2 kJ
B. -702.0 kJ
C. -920.6 kJ
D. -1492.4 kJ

Use the following information to answer question 10.

The graph shows the results of an experiment to determine the molar heat of fusion of water.



10. A possible reason for the change in direction of the graph after 2.2 min is that

A. some of the water was freezing and was absorbing heat from the water

B. the room was warmer than the water and some heat was entering the calorimeter from the room

C. the room was colder than the water and some heat was entering the calorimeter from the room

D. the room was colder than the water and some heat was leaving the calorimeter

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Use the following information to answer question 11.

$\frac{1}{8}S_8(s) \longrightarrow S(g)$	$\Delta H = +277$ kJ
$\frac{1}{4}S_8(s) \longrightarrow S_2(g)$	$\Delta H = +129$ kJ
$S_8(s) \longrightarrow S_8(g)$	$\Delta H = +101$ kJ

11. Which of these forms of sulphur has more potential energy than 4 mol of $S_2(g)$?

A. $4S_2(s)$
B. $S_8(s)$
C. $S_8(g)$
D. $8S(g)$

Use the following information to answer question 12.

In a calorimetric experiment,

I. the amount of heat involved is dependent on the mass of the reactant used

II. the amount of heat involved is dependent on the temperature change occurring in the system

III. the heat involved is completely transferred to the calorimeter water

IV. stirring speeds up the heat transfer so thermal equilibrium is reached quicker

12. Which statement(s) is(are) an assumption?

A. IV only
B. III only
C. I and II only
D. I, II, III, and IV

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13. If a student warms 170 g of sugar solution from 18.8°C to 65.2°C with 41.2 kJ of energy, the specific heat capacity of the sugar solution is

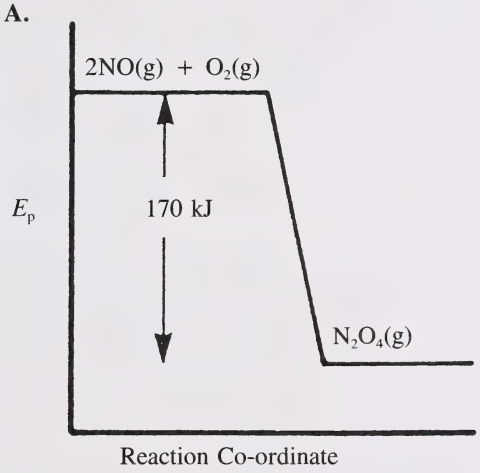
A. 12.9 J/g°C
B. 11.2 J/g°C
C. 5.22 J/g°C
D. 4.19 J/g°C

Use the following information to answer question 14.

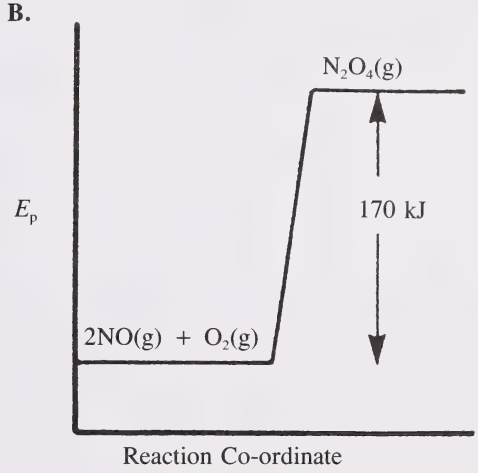
$N_2O_4(g) \longrightarrow 2NO_2(g)$	$\Delta H = +58$ kJ
$NO(g) + \frac{1}{2}O_2(g) \longrightarrow NO_2(g)$	$\Delta H = -56$ kJ

14. The diagram that correctly represents the reaction $2NO(g) + O_2(g) \longrightarrow N_2O_4(g)$ is

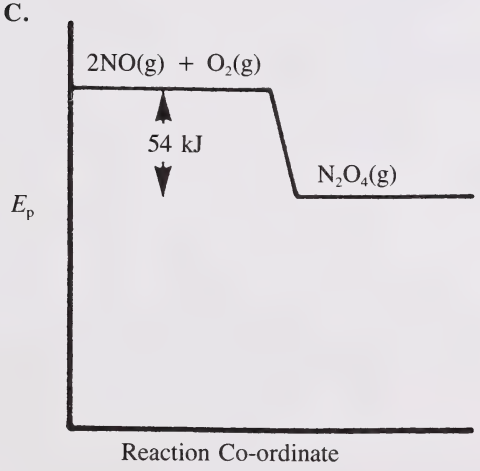
A.



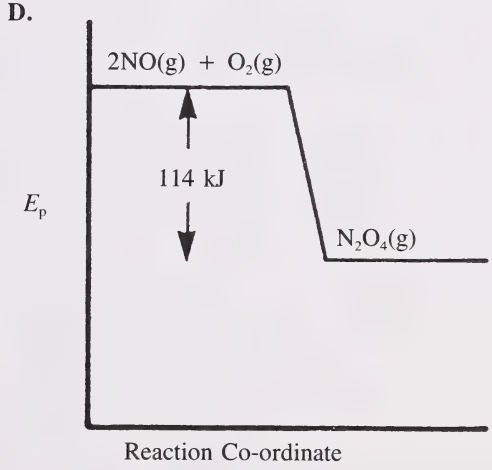
B.



C.



D.



15. In a calorimetric experiment, the burning of 5.75 g of cyclobutane, $C_4H_8(l)$, caused the temperature of 4.40 kg of calorimeter water to increase by 9.30°C. Data indicate that the molar heat of combustion of cyclobutane is

A. -1.76×10^1 kJ/mol
B. -1.71×10^2 kJ/mol
C. -2.20×10^2 kJ/mol
D. -1.67×10^3 kJ/mol

16. A correct description of the action of a base is that a base

A. decreases the pH of an aqueous solution
B. decreases $[OH^-(aq)]$ of an aqueous solution
C. donates protons in chemical reactions
D. accepts protons in chemical reactions

17. Which of the following is a neutralization reaction?

A. base + salt $\longrightarrow$ acid + water
B. salt + water $\longrightarrow$ acid + base
C. acid + salt $\longrightarrow$ base + water
D. acid + base $\longrightarrow$ salt + water

18. Arrhenius defined an acid as a substance that

A. tastes sour
B. turns litmus blue
C. increases the concentration of $H^+(aq)$ in a solution
D. increases the concentration of $OH^-(aq)$ in a solution

19. An example of a neutralization reaction is

A. $BaCl_2(aq) + Na_2SO_4(aq) \longrightarrow BaSO_4(s) + 2NaCl(aq)$

B. $H_2SO_3(aq) + NH_3(aq) \longrightarrow NH_4^+(aq) + HSO_3^-(aq)$

C. $3CoCl_2(aq) + 2Al(s) \longrightarrow 2AlCl_3(aq) + 3Co(s)$

D. $Sn^{2+}(aq) + Zn(s) \longrightarrow Sn(s) + Zn^{2+}(aq)$

Use the following information to answer question 20.

When rainwater falls, it can become slightly acidic due to the presence of combustion products in the atmosphere. A pH recording of 5.6 for rainwater is not uncommon.

20. The Brønsted-Lowry equation that explains the acidic nature of rainwater is

A. $2H_2O(l) \leftrightharpoons H_3O^+(aq) + OH^-(aq)$
B. $2H_2O(l) \leftrightharpoons O_2(g) + 4H^+(aq) + 4e^-$
C. $CO_2(g) + H_2O(l) \leftrightharpoons OH^-(aq) + HCO_2^+(aq)$
D. $CO_2(g) + 2H_2O(l) \leftrightharpoons H_3O^+(aq) + HCO_3^-(aq)$

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21. In 0.10 mol/L $CH_3COOH(aq)$,

A. there are more ions than molecules in the solution
B. there are more molecules than ions in the solution
C. the concentration of $H_3O^+(aq)$ is significantly greater than the concentration of $CH_3COO^-(aq)$
D. the number of ions is equal to the number of undissociated molecules

Use the following information to answer question 22.

Four solutions of equal concentration were tested for conductivity, reaction to litmus, and reaction with zinc metal. The results were tabulated:

Solution	Conductivity	Litmus	Zinc
I	good	blue to red	produced $H_2(g)$
II	good	no change	no reaction
III	poor	blue to red	produced $H_2(g)$
IV	none	no change	no reaction

22. The solution that would be considered to be a solution of a weak acid is

A. I
B. II
C. III
D. IV

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23. A negative pH would be observed in a solution in which

A. $[H_3O^+(aq)] < [OH^-(aq)]$

B. $[H_3O^+(aq)] > 1.0$ mol/L

C. $[H_3O^+(aq)] < 1.0 \times 10^{-14}$ mol/L

D. $[H_3O^+(aq)] < 1.0 \times 10^{-7}$ mol/L

24. The pH of 7.5×10^{-5} mol/L $Ba(OH)_2(aq)$ is

A. 10.18
B. 9.88
C. 4.12
D. 3.82

25. If 20.0 mL of 0.100 mol/L NaOH(aq) are added to 40.0 mL of 0.100 mol/L HCl(aq) containing phenolphthalein and bromothymol blue, the resulting solution will be

A. blue
B. pink
C. yellow
D. colorless

Use the following information to answer question 26.

Several indicators were placed in different test tubes that each contained the same solution. These observations were recorded:

Test Tube	Indicator	Color
I	methyl orange	yellow
II	phenol red	red
III	phenolphthalein	colorless
IV	indigo carmine	blue

26. The pH of the solution was most likely

A. 4.8
B. 6.2
C. 8.1
D. 11.4

27. In the chemical equation $NH_3(aq) + H_2O(l) \leftrightharpoons NH_4^+(aq) + OH^-(aq)$, a Brønsted-Lowry conjugate acid-base pair is

A. $H_2O(l)$, $OH^-(aq)$

B. $NH_3(aq)$, $H_2O(l)$

C. $NH_4^+(aq)$, $OH^-(aq)$

D. $NH_4^+(aq)$, $H_2O(l)$

Use the following information to answer question 28.

A statement and an explanation are given for this reaction:

$$NH_3(aq) + H_2O(l) \leftrightharpoons NH_4^+(aq) + OH^-(aq)$$

Statement	Explanation
In the reaction, $OH^-(aq)$ acts as a base	because the $OH^-(aq)$ feels slippery and will turn red litmus blue.

28. Based on the reaction, one should conclude that

A. both the statement and the explanation are true, and the explanation is correct for the statement

B. both the statement and the explanation are true, but the explanation is not correct for the statement

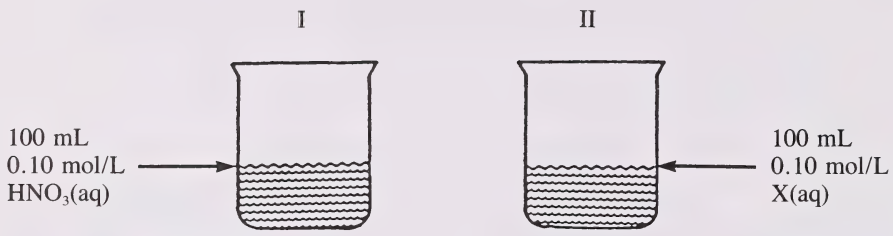
C. the statement is true, but the explanation is false

D. the statement is false, but the explanation is true

29. Which of these 0.10 mol/L acidic solutions is dissociated least at 25°C?

A. $H_2SO_3(aq)$
B. $HNO_2(aq)$
C. $H_2S(aq)$
D. HF(aq)

Use the following information to answer question 30.



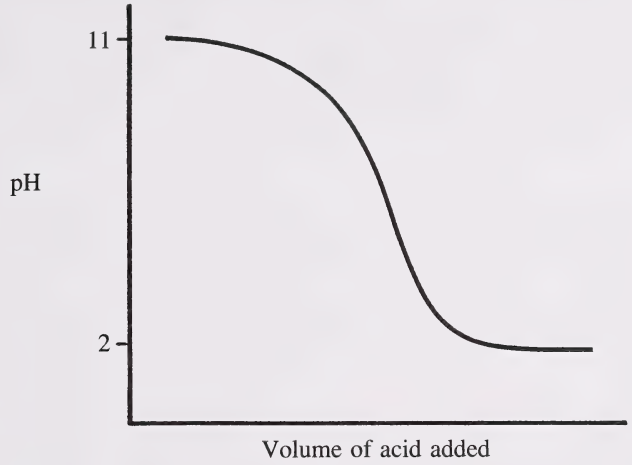
When the solution in beaker I is poured into beaker II, the pH of the resulting solution is approximately 4.

30. Solution X(aq) could be

A. NaOCl(aq)
B. $KHSO_4(aq)$
C. HBr(aq)
D. KOH(aq)

Use the following information to answer question 31.

- Titration curve for 0.10 mol/L solutions of HCl(aq) and $NH_3(aq)$



- A student titrated an $NH_3(aq)$ solution of unknown concentration with 0.10 mol/L HCl(aq) solution. The indicator used was methyl violet. The following data were obtained when the indicator turned green:

Trial No.	I	II	III
Volume of acid	22.32 mL	27.36 mL	24.25 mL

31. To improve the procedure so as to obtain more reliable results, the student should

A. perform more trials
B. use a weaker acid in the titration
C. use a weaker base in the titration
D. use chlorophenol red instead of methyl violet

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32. A student dissolves 5.0 g of KOH(s) in water to make 2.0 L of solution. The $[H_3O^+(aq)]$ of this solution is

A. 4.5×10^{-16} mol/L
B. 2.2×10^{-13} mol/L
C. 4.5×10^{-13} mol/L
D. 4.5×10^{12} mol/L

33. The process of reduction is correctly expressed by which of these half-reactions?

A. $Cu^{+}(aq) \longrightarrow Cu^{2+}(aq) + e^{-}$

B. $Cl_2(g) \longrightarrow 2Cl^{-}(aq) + 2e^{-}$

C. $Au^{+}(aq) + 2e^{-} \longrightarrow Au^{3+}(aq)$

D. $Pb^{4+}(aq) + 2e^{-} \longrightarrow Pb^{2+}(aq)$

34. In the equation $Pb^{2+}(aq) + 2Cr^{2+}(aq) \longrightarrow 2Cr^{3+}(aq) + Pb(s)$, the reducing agent is

A. $Cr^{2+}(aq)$
B. $Pb^{2+}(aq)$
C. $Cr^{3+}(aq)$
D. $H_2O(l)$

35. An oxidizing agent is a substance that promotes a redox reaction by

A. donating electrons in a reduction half-reaction
B. gaining electrons in an oxidation half-reaction
C. gaining electrons in a reduction half-reaction
D. donating electrons in an oxidation half-reaction

36. The net ionic equation for the reaction that occurs when potassium permanganate solution is titrated with acidified iron(II) sulphate solution is

A. $MnO_2(s) + 4H^{+}(aq) + 2Fe^{2+}(aq) \longrightarrow Mn^{2+}(aq) + 2H_2O(l) + 2Fe^{3+}(aq)$

B. $MnO_4^{-}(aq) + 8H^{+}(aq) + 5Fe^{2+}(aq) \longrightarrow Mn^{2+}(aq) + 4H_2O(l) + 5Fe^{3+}(aq)$

C. $4Mn^{2+}(aq) + 6H_2O(l) + 5O_2(g) \longrightarrow 4MnO_4^{-}(aq) + 12H^{+}(aq)$

D. $4MnO_4^{-}(aq) + 12H^{+}(aq) \longrightarrow 4Mn^{2+}(aq) + 6H_2O(l) + 5O_2(g)$

37. The oxidation number for carbon in methanoic acid, HCOOH, is

A. -2
B. -1
C. $+1$
D. $+2$

38. The balanced reduction half-reaction for the reduction of $Nb_2O_5(s)$ to Nb(s) in an acidic solution is

A. $Nb_2O_5(s) + 10H^+(aq) + 10e^- \longrightarrow 2Nb(s) + 5H_2O(l)$

B. $Nb_2O_5(s) + 5H^+(aq) + 5e^- \longrightarrow Nb(s) + 5H_2O(l)$

C. $Nb_2O_5(s) + 2H^+(aq) + 2e^- \longrightarrow Nb(s) + H_2O(l)$

D. $Nb_2O_5(s) + 5e^- \longrightarrow 2Nb(s) + \frac{5}{2}O_2(g)$

Use the following information to answer question 39.

Kim and Tracy were assigned to make a standard solution of potassium permanganate and to use it to determine the concentration of tin(II) ion in a solution of unknown concentration.

Kim used 1.50 g and Tracy used 1.00 g of $KMnO_4$. Each amount was dissolved in enough water to make 250 mL of solution, and the solutions were allowed to stand for 24 h.

Both solutions of $KMnO_4$ were standardized against an acidic solution of iron(II) ion of known concentration and then used to determine the concentration of tin(II) ion in the solution of unknown concentration.

39. If both students followed correct procedures, the calculated value for the concentration of tin(II) ion was

A. higher for Kim's experiment because his $[MnO_4^-(aq)]$ was higher than Tracy's

B. higher for Tracy's experiment because her $[MnO_4^-(aq)]$ was lower than Kim's

C. lower for Tracy's experiment because her $[MnO_4^-(aq)]$ was lower than Kim's

D. the same for both experiments within experimental uncertainty

Use the following information to answer question 40.

$X^{2+}(aq) + 2e^- \longrightarrow X(s)$	E° = ?
$Zn(s) \longrightarrow 2e^- + Zn^{2+}(aq)$	E° = +0.76 V
$X^{2+}(aq) + Zn(s) \longrightarrow X(s) + Zn^{2+}(aq)$	E°_{net} = +0.62 V

40. X(s) is most likely

A. Mg(s)
B. Sn(s)
C. Cd(s)
D. Pb(s)

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41. The reduction potential of the half-reaction $2H^+(aq) + 2e^- \longrightarrow H_2(g)$ is 0.0 V because

A. $H^+(aq)$ will not be reduced
B. $H^+(aq)$ is a weak oxidizing agent
C. the voltage is arbitrarily assigned
D. this half-cell has no measurable voltage

Use the following information to answer question 42.

$2J(s) + L^{2+}(aq) \longrightarrow 2J^+(aq) + L(s)$

$L(s) + M^{2+}(aq) \longrightarrow$ No Reaction

$N(s) + M^{2+}(aq) \longrightarrow N^{2+}(aq) + M(s)$

$M(s) + 2J^+(aq) \longrightarrow 2J(s) + M^{2+}(aq)$

42. Which species is the strongest oxidizing agent?

A. $J^+(aq)$
B. $L^{2+}(aq)$
C. $M^{2+}(aq)$
D. $N^{2+}(aq)$

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43. The reducing agent that could **not** be used to reduce $Fe^{3+}(aq)$ is

A. Sn(s)

B. $H_2(g)$

C. $I^-(aq)$

D. $Cl^-(aq)$

Use the following information to answer question 44.

A student constructed an electrochemical cell composed of a $Fe^{3+}(aq)/Fe(s)$ half-cell connected to an unknown half-cell. With Fe as the anode, the E°_{net} for the cell was 0.58 V. The same unknown half-cell was connected to a $Ag^+(aq)/Ag(s)$ half-cell and the silver electrode was the cathode.

44. If the unknown half-cell contained M(s) as the metal electrode and $M^{2+}(aq)$ ions in solution, then the metals M(s), Ag(s), and Fe(s) in order of decreasing reducing agent strength were

A. Fe(s), M(s), Ag(s)
B. Fe(s), Ag(s), M(s)
C. M(s), Ag(s), Fe(s)
D. Ag(s), M(s), Fe(s)

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45. The E°_{net} for the reaction
$Pb(s) + 2SO_4^{2-}(aq) + 4H^+(aq) \longrightarrow H_2SO_3(aq) + PbSO_4(s) + H_2O(l)$ is

A. +0.56 V
B. +0.16 V
C. −0.16 V
D. −0.56 V

46. Which of the following reactions is nonspontaneous?

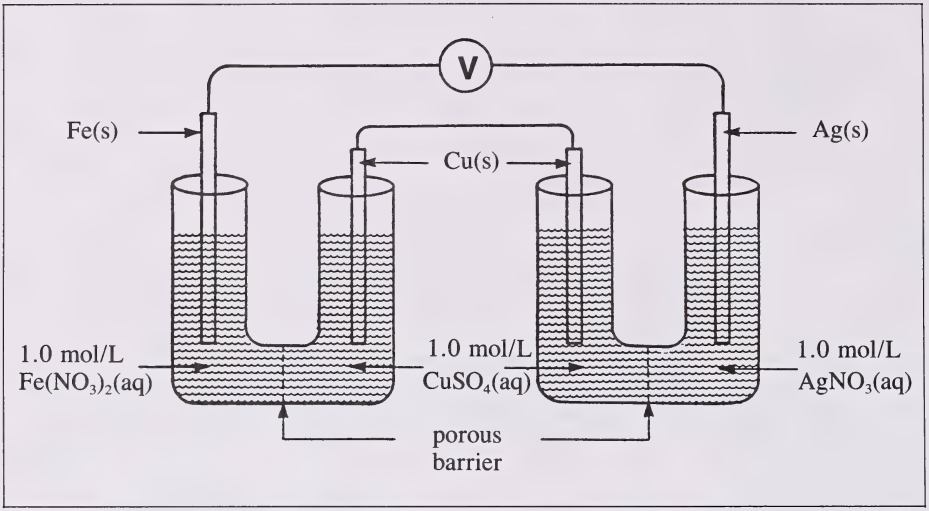
A. $I_2(s) + Fe(s) \longrightarrow 2I^-(aq) + Fe^{2+}(aq)$

B. $2Fe^{3+}(aq) + 3Sn^{2+}(aq) \longrightarrow 2Fe(s) + 3Sn^{4+}(aq)$

C. $2Li(s) + 2H_2O(l) \longrightarrow 2Li^+(aq) + 2OH^-(aq) + H_2(g)$

D. $2Cl_2(g) + 2H_2O(l) \longrightarrow 4Cl^-(aq) + O_2(g) + 4H^+(aq)$

Use the following diagram to answer question 47.



47. The reading on the voltmeter is

A. 0.00 V
B. 0.29 V
C. 0.68 V
D. 1.21 V

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48. Which of the following statements about electrolytic cells is **true**?

A. They are used as power sources.
B. Spontaneous reactions occur in them.
C. Reduction takes place at the cathode.
D. Electrons move through the solution from anode to cathode.

49. How many moles of electrons are required to completely reduce 1.5 mol of $Fe^{3+}(aq)$ to Fe(s)?

A. 4.5 mol
B. 3.0 mol
C. 1.5 mol
D. 0.5 mol

YOU HAVE NOW COMPLETED THE MULTIPLE-CHOICE PART OF THE EXAMINATION. PROCEED DIRECTLY TO PART B.

PART B

INSTRUCTIONS

In this part of the examination, there are seven machine-scorable open-ended questions each with a value of one mark. All numbers used in the questions are to be considered as the result of a measurement.

Read each question carefully.

Solve each question and write your answer to three digits.

Record your answer on the answer sheet provided by writing it in the boxes of the corresponding answer field and by filling in the circles that match your answer. **Use an HB pencil only**.

Sample Question and Solution

1. The mass in grams of silver produced when 0.220 mol of silver nitrate reacts with excess copper, to three digits, is _____ g.

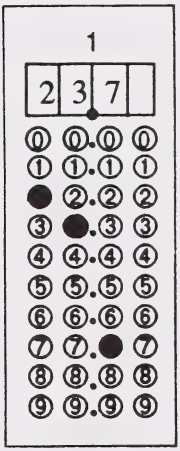
$$\text{mass}_{Ag} = 0.220 \text{ mol} \times 107.87 \text{ g/mol}$$

$$= 23.7314 \text{ g}$$

$$= 23.7 \text{ g (rounded to three digits)}$$

Record 23.7

Answer Sheet



If you wish to change an answer, erase your first answer completely.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work. **No marks** will be given for work done on the tear-out pages.

START PART B IMMEDIATELY.

1. If complete combustion of 3.00 g of methane gas in a calorimeter causes the temperature of 3.75 kg of water to increase from 25.0°C to 35.5°C, then the heat of combustion of methane in kilojoules per mole, to three digits, is $-$_____ $\times$ 10^2 kJ/mol.

RECORD THE ANSWER ON THE ANSWER SHEET

2. In respiration, glucose ($C_6H_{12}O_6$) is oxidized to CO_2(g) and $H_2O(l)$. When 1.80 g of glucose are oxidized, the heat released in kilojoules, to three digits, is _____ kJ.

RECORD THE ANSWER ON THE ANSWER SHEET

3. During an experiment to determine the relative strengths of acids, 8.00 g HF dissolved in 2.00 L of water, yielding a pH of 2.080. Based on these data, the per cent ionization of this acid, to three digits, is _____ %.

RECORD THE ANSWER ON THE ANSWER SHEET

4. A standard solution of KOH(aq) was used to titrate a monoprotic unknown solid acid sample (HA) until the endpoint was reached. The following data were obtained:

Mass of acid in sample	2.50 g
Concentration of standard KOH(aq)	1.00 mol/L
Final burette reading of KOH(aq)	30.64 mL
Initial burette reading of KOH(aq)	1.50 mL

The molar mass of the unknown acid in grams per mole, to three digits, is _____ g/mol.

RECORD THE ANSWER ON THE ANSWER SHEET

5. A 20.5 mL sample of $NH_3(aq)$ is titrated to an endpoint using 30.3 mL of HBr(aq) with a pH of 1.650. The $[NH_3(aq)]$ in the sample in moles per litre, to three digits, is _____ $\times$ 10^{-2} mol/L.

RECORD THE ANSWER ON THE ANSWER SHEET

Use the following data to answer question 6.

In a titration experiment, $K_2Cr_2O_7(aq)$ was used to determine the concentration of $Fe^{2+}(aq)$ in an acidified solution of $FeCl_2(aq)$. The following data were recorded:

Concentration of $K_2Cr_2O_7(aq)$	0.250 mol/L
Volume of $FeCl_2(aq)$	10.00 mL
Final burette reading of $K_2Cr_2O_7(aq)$	30.2 mL
Initial burette reading of $K_2Cr_2O_7(aq)$	0.2 mL

6. The concentration of $Fe^{2+}(aq)$ ions in the $FeCl_2(aq)$ solution in moles per litre, to three digits, is _____ mol/L.

RECORD THE ANSWER ON THE ANSWER SHEET

Interpret the following observations to answer question 7.

A student collected data for reactions using hydrogen and two unidentified metals labelled X(s) and Y(s).

$$H_2(g) + Y^{2+}(aq) \longrightarrow 2H^+(aq) + Y(s) \qquad E^\circ_{net} = 0.40 \text{ V}$$

$$Y^{2+}(aq) + X(s) \longrightarrow Y(s) + X^{2+}(aq) \qquad E^\circ_{net} = 1.55 \text{ V}$$

7. The standard reduction potential for the reaction $X^{2+}(aq) + 2e^- \longrightarrow X(s)$ in volts, to three digits, is $-$_____ V.

RECORD THE ANSWER ON THE ANSWER SHEET

YOU HAVE NOW COMPLETED THE MACHINE-SCORABLE OPEN-ENDED PART OF THE EXAMINATION. PROCEED DIRECTLY TO PART C.

PART C

INSTRUCTIONS

In this part of the examination, there are three written-response questions for a total of 14 marks. All numbers used in the questions are to be considered as the result of a measurement.

Write your solutions in the examination booklet as neatly as possible.

Your solutions **must show all** pertinent explanations, calculations, and formulas. Full marks will be assigned **only** to those solutions that **show** all pertinent explanations, calculations, and formulas.

All numerical answers must be given correct to the appropriate number of significant digits.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work. **No marks** will be given for work done on the tear-out pages.

START PART C IMMEDIATELY.

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(5 marks)

1. 1.0 g of ethanol was burned in a bomb calorimeter containing 0.200 kg of water at 24°C. The products of combustion were gaseous carbon dioxide and liquid water. Predict the final temperature of the calorimeter's water.

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2. Pat and Lynn were discussing methods of classifying acids. Pat explained that one way to classify substances as acids was their ability to donate a proton. Lynn countered with the statement that Pat's classification was meaningless because all atoms contain protons and therefore all substances would be acids.

a. Identify and explain which explanation was incorrect.

Gene, another student in the class, classified a solution as acidic by using two indicators to determine that the solution had a pH between 3.8 and 4.8.

b. What indicators would Gene have used? What would the observations have been? Your answer must include an explanation of how the approximate pH was determined from these observations.

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(5 marks)

3. To determine the concentration of an unknown HCl(aq) solution, 3.00 g of Zn(s) were added to 0.100 L of the acid solution. When no further reaction was observed, the remaining Zn(s) was removed, dried, and weighed. Its mass was 1.44 g.

   a. Write the redox equation for the reaction that occurred.

   b. Determine the concentration of the unknown acid solution.

   c. What observation would indicate that the reaction was completed?

YOU HAVE NOW COMPLETED THE EXAMINATION. IF YOU HAVE TIME, YOU MAY WISH TO GO BACK AND CHECK YOUR ANSWERS.

(NO MARKS WILL BE GIVEN FOR WORK DONE ON THIS PAGE)

FOLD AND TEAR ALONG PERFORATION

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FOLD AND TEAR ALONG PERFORATION

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M1 M2 M3 M4

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CHEMISTRY 30

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CHEMISTRY 30